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PUCT REVIEW OF REAL-TIME
CO-OPTIMIZATION IN THE ERCOT
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**ELECTRIC RELIABILITY COUNCIL OF TEXAS, INC.'S REPORT
ON THE MULTI-INTERVAL REAL-TIME MARKET FEASIBILITY STUDY**

Electric Reliability Council of Texas, Inc. (ERCOT) hereby provides the attached report entitled "Summary of Multi-Interval Real-Time Market (MIRTM) Feasibility Study" ("MIRTM Report") to the Public Utility Commission of Texas (Commission). The MIRTM Report is a follow-up to the December 9, 2016 Status Update filed in this Project.

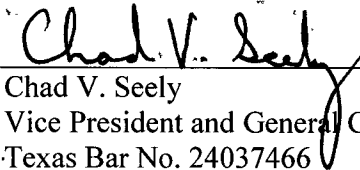
Consistent with the plan in the Status Update, following a more than year-long effort, ERCOT submitted a draft Summary of the MIRTM Report to the Supply Analysis Working Group (SAWG) in early January 2017 for review at its January 17, 2017 and February 6, 2017 meetings. At its March 1, 2017 meeting, the Wholesale Market Subcommittee (WMS) endorsed the Summary of the MIRTM Report and advanced the document to the Technical Advisory Committee (TAC), which also endorsed the Summary at its March 23, 2017 meeting. On April 4, 2017, ERCOT staff provided an update to the ERCOT Board of Directors (ERCOT Board) on the procedural history, findings and conclusions of the MIRTM Report. Attached hereto is the final MIRTM Report presented at the April 4, 2017 ERCOT Board meeting.

In summary, the MIRTM Report concludes that "ERCOT and stakeholders find that the MIRTM study demonstrates that the estimated cost are in excess of the measured benefits and therefore insufficient to support a recommendation to move forward with MIRTM at this time." Although the conclusion at this time does not support moving forward with the implementation of MIRTM, future market conditions may differ from those during which the MIRTM Report was

based, and the work performed for the MIRTTM Report will provide a valuable starting point for any future reassessment of the value of MIRTTM in the ERCOT market.

As noted at the outset, the MIRTTM study effort has been a more than year-long, iterative process involving significant resource commitments on the part of both ERCOT staff and stakeholders, and ERCOT greatly appreciates the involvement of the stakeholder community in this discussion. ERCOT further appreciates the opportunity to provide this MIRTTM Report to the Commission, and will be available to discuss any questions or comments at the Commission's April 13, 2017 Open Meeting.

Respectfully submitted,



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Summary of Multi-Interval Real Time Market (MIRTM)

Feasibility Study

BACKGROUND

- In the current ERCOT real-time market, software dispatches and prices energy in single five minute intervals. It does not commit or de-commit resources and does not consider potential changes in system conditions more than five minutes into the future. Generally, the ERCOT Nodal Real Time Market relies on generation owners (QSEs) to self-commitment/self-decommitment based on the generator owner's anticipation of future real time market prices.
- This construct has limitations in that it is unable to coordinate the economic commitment of resources such as combustion turbine Generation Resources and Load Resources providing demand response that are available within 10-30 minutes but unable to respond within five minutes. Additionally, these resources may be less flexible than online resources due to operational constraints (e.g., start-up times, minimum loading requirements, minimum or maximum run times, etc.).
- Soon after nodal go-live, The Nodal Protocols were modified to provide an "optional work-around" solution to effectively commit and dispatch Quick Start Generation Resources (QSGRs) in the Real Time market:
 - QSGRs capable of coming online within 10 minutes are allowed to telemeter a status of online although physically offline, and also to telemeter a low sustainable limit (LSL) of zero MW even though their physical LSL is greater than zero.
 - Under this approach, QSGRs are dispatched by SCED as if the generator is already online even though they are physically unable to respond for the first 10 minutes. As a result, regulation reserves are deployed to balance the system.
 - Many operators of fast responding Generation Resources such as combustion turbines cannot meet the QSGR requirements and therefore have no other option than to self-commit. Other QSGR-qualified Generation Resources choose not to participate as QSGRs in SCED and instead self-commit. These fast responding Generation Resources that choose the self-commitment path will have to factor in their expectation of prices and weigh that against their costs over the expected run-time of the Generation Resource
- A MIRTM could potentially improve the efficiency of the short term commitment decisions, dispatch and pricing of resources such as combustion turbine Generation Resources and Load Resources providing demand response by coordinating the commitment and honoring the resources' temporal constraints and by reflecting the physical realities of the system.

WHAT WOULD CHANGE WITH THE IMPLEMENTATION OF MIRTM?

- In contrast to the current design which evaluates single five minute intervals, in the MIRTM construct the real-time market software will analyze multiple consecutive five-minute intervals (the "MIRTM horizon") to determine the most economical commitment and dispatch of resources.

- The MIRTM horizon enables the coordination of a more efficient commitment and dispatch of the current fleet of resources, and also could be expected to enhance competition by attracting more resources, especially demand response, to the real-time market. For Load Resources not providing Ancillary Services would also receive an ORDC payment to offset the costs of operating as a fully integrated Load Resource in ERCOT's systems.
- For MIRTM to be effective, accurate forecasting of system conditions over the MIRTM horizon is critical. Important inputs to MIRTM include:
 - Short-term load forecast
 - Current actual load (GTBD)
 - Intermittent (wind, solar) resource capacity short-term forecasts
 - Projected Resource status
- Commitment instructions issued by MIRTM would be binding, but Locational Marginal Prices (LMPs) would be binding for only the next (current) five-minute interval.
- To ensure that fast responding Generation Resources such as combustion turbines and Load Resources committed by MIRTM contribute to system wide price formation when they are marginal to meet system demand, a SCED pricing run using the mechanics in NPRR 626 would be applied.
- Resources committed by MIRTM would be eligible for "make-whole" payments if real-time LMPs are insufficient to recover the three part offer costs over the resources run time. Increased accuracy in the forecast of system conditions and effective price setting by marginal resources should both work to minimize the frequency and magnitude of "make-whole" payments.
- MIRTM could replace the existing approach for the dispatch of QSGRs.
- Resources would retain the ability to self-commit if they so choose.
 - There is a concern that there exists the potential for Resources that self-commit to increase make-whole payments as the previous MIRTM runs could have committed Fast Responding Generation Resources or Load Resources without the knowledge that a Resource would be self-committing in the future.
 - If MIRTM were to move forward, the interaction between MIRTM commitment and self-commitment would need to be addressed.

FINDINGS FROM MIRTM STUDY

- ERCOT developed a software platform in-house to perform MIRTM simulations for selected operating days in 2015 and 2016 for purposes of assessing MIRTM feasibility and evaluating MIRTM's potential production cost savings (a measure of economic efficiency).
- The simulations demonstrate that the MIRTM approach is feasible for both Fast Responding Generation Resources (FRGRs) and Load Resources (LRs) that have temporal constraints.
 - With centralized commitment and dispatch, the scope of potential participation in the real-time market is expanded to include FRGRs and LRs that currently can only participate in the real-time market through voluntary self-commitment.
 - Increased participation in the real-time market by FRGRs and LRs would provide ERCOT with improved system visibility and operational flexibility.
- For now, the MIRTM simulation study window of 30 minutes appears to strike a reasonable balance between net load forecast accuracy and the scope of potential participation by FRGRs and LRs in MIRTM.

- A shortened window of 15 minutes would significantly limit the scope of potential participation by FRGRs and LRs.
- A lengthened window to 45 minutes to one hour may increase the scope of participation by FRGRs and LRs, but would increase the net load forecast error.
- If implemented, the MIRTm window would be configurable such that it may be expanded or contracted based on operating experience to achieve the optimal balance between participation and net load forecast accuracy.

CONCLUSIONS

- On average, the MIRTm simulations did not indicate significant production cost savings for the operating days studied in 2015 and 2016.
 - This result is influenced by the fact that system conditions and the balance of supply and demand during the period studied did not present a significant need for the types of resources that would participate in MIRTm.
 - Changes in the future resource mix, the balance of supply and demand or system conditions could demonstrate more significant value to MIRTm.
 - ERCOT has previously estimated the cost for ERCOT system changes needed to support MIRTm in the range of \$20-\$25 M. The costs to QSE systems were not estimated.
- Generally, the MIRTm simulation produces a tighter commitment pattern for FRGRs and LRs compared to the current system.
 - A tighter commitment pattern indicates a desirable outcome where the FRGRs' and LRs' capacity utilization is maximized (e.g., if a FRGR is committed, its dispatch level is above its LSL).
 - In some cases, the MIRTm simulations resulted in more price spikes than Sequential SCED. If MIRTm were to be implemented, the improvements noted below could mitigate the number and severity of price spikes.
- For the days studied in the MIRTm simulation, significant make-whole payments were not required for FRGRs or LRs committed by MIRTm.
- Potential improvements to the forecasted inputs to MIRTm could include:
 - Resource status forecasts (e.g., Start Up, Shut Down, On Test)
 - Accuracy of short-term Intermittent Renewable Resource forecasts
 - Accuracy of the short-term load forecast
 - Changes in Ancillary Service (AS) requirements across the hour boundary and associated Resource AS responsibility changes and Non Frequency Responsive Capability (NFRS) that impacts a Resources High Dispatch Limit (HDL)
 - DC Tie schedule changes on a five-minute boundary (the MIRTm study used DC tie schedule changes on a 15 minute boundary)
 - Local price formation for FRGRs and LRs committed by MIRTm (i.e., improvements to NRR626 RT Deployment Price Adder)
 - Inclusion of higher configurations for online combined-cycle generators as eligible for commitment by MIRTm (e.g., 1x1 to 2x1, or 2x1 to 2x1 + duct burner)
 - Consideration of impacts from upcoming planned Resource status changes including outages and Transmission outages in the MIRTm study horizon

- Considering the results of the limited analysis, ERCOT and stakeholders find that the MIRTM study demonstrates that the estimated cost are in excess of the measured benefits and therefore insufficient to support a recommendation to move forward with MIRTM at this time.